DEVELOPMENT OF COMPUTER AIDED GAUSS MODEL TO STUDY THE DISPERSION OF AIR POLLUTANTS

A PROJECT REPORT SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIRMENTS FOR THE DEGREE OF

BACHELOR OF TECHNOLOGY

IN

CIVIL ENGINEERING

BY

BISWABIKASH ROUT

(10301031)

AND

SOURAVA KUMAR SETHY

(10301006)

DEPARTMENT OF CIVIL ENGINEERING
NATIONAL INSTITUTE OF TECHNOLOGY
ROURKELA, ORISSA - 769008

2007

DEVELOPMENT OF COMPUTER AIDED GAUSS MODEL TO STUDY THE DISPERSION OF AIR POLLUTANTS

A PROJECT REPORT SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIRMENTS FOR THE DEGREE OF

BACHELOR OF TECHNOLOGY

IN

CIVIL ENGINEERING

BY

BISWABIKASH ROUT

(10301031)

AND

SOURAVA KUMAR SETHY

(10301006)

UNDER THE GUIDANCE OF
Mr. SOMESH JENA
(Dept of civil engineering)

DEPARTMENT OF CIVIL ENGINEERING
NATIONAL INSTITUTE OF TECHNOLOGY
ROURKELA, ORISSA - 769008
2007

NATIONAL INSTITUTE OF TECHNOLOGY ROURKELA

CERTIFICATE

This is to certify that the project report entitled, "DEVELOPMENT OF COMPUTER AIDED GAUSS MODEL TO STUDY THE DISPERSION OF AIR POLLUTANTS" submitted by Sri Biswabikash Rout and Sourava Kumar Sethy in partial fulfillment of the requirements for the award of Bachelor of Technology Degree in Civil Engineering at the National Institute of Technology, Rourkela (Deemed University) is an authentic work carried out by him under my supervision and guidance.

To the best of my knowledge, the matter embodied in the project report has not been submitted to any other University/ Institute for the award of any Degree or Diploma.

Date:

Prof. Somesh Jena
Dept. of Civil Engineering
National Institute of Technology
Rourkela, 769008

ACKNOWLEDGEMENT

I wish to express my deep sense of gratitude and indebtedness to **Prof. Somesh Jena,** Department of Civil Engineering, N.I.T Rourkela for introducing the present topic and for their inspiring guidance, constructive criticism and valuable suggestion throughout this project work.

I would like to express my gratitude to **Dr.K.C.Patra (**Head of the Department), for his valuable suggestions and encouragements at various stages of the work.

I am also thankful to all the staffs in Department of Civil Engineering for providing all joyful environments in the lab and helping me out in different ways.

Last but not least, my sincere thanks to all my friends who have patiently extended all sorts of help for accomplishing this undertaking.

Date: **Biswabikash Rout**

Sourava kumar sethy

CONTENTS

ABSTRACT

Gaussian plume concept and formula (model) is one example of computational modes in which if and when the exact conditioned specified by parameters occur then Gaussian plume formulas will give fair approximation of the isopleths contours and the orders of magnitude of the concentration be expected. Dispersion co-efficient, pasquill's stability categories were taken into account and GAUSS MODEL (C++ program) is created to find ground level concentration around RSP. The result obtained is validated with existing records and error is found out. The contours for concentration of various pollutants were drawn. With help of cleanvironment Pvt. Ltd. Field monitoring was done using respirable dust sampler at Kuarmunda area.

LIST OF TABLES

LIST OF FIGURES

CHAPTER: 1

Introduction

CHAPTER 1

INTRODUCTION

The rapid industrialization, fast urbanization and various other activities of making have disturbed the balance of natural atmosphere. The survival of any living organism is on the breathing of pure natural air and if it gets polluted due to any reason, various undesirable and serious effects become prominent and noticeable. The air pollution may be defined as “ the presence in such a quantities and of such duration as may be or may tent to be injurious to human, plants, animals or property which unreasonably interferers with the comfortable enjoyment of life property or conduct of business”.

Most economic activities, involving the use and conversion of energy, transportation is prominently accompanied by emissions of air pollutants, degrading the environment, and in particular the urban environment. Urban air pollution, in turn is the source of a range of problems, including heaths risks with inhalation of gas and particles, accelerated corrosion and deterioration of materials, damage to historical monuments And buildings, and damage to vegetation in and near the city.

Many different substances and compounds are consideration as air pollution. They are generally of anthropogenic origin, and result in their majority, from combustion process of fossil fuels. The most common gaseous contaminants in the urban atmosphere are sulphur dioxide, carbon mono-oxide, ozone and oxidants, oxides of nitrogen, hydrocarbons and aldehydes. There are also natural pollutants such as gases and dust from volcanoes, forest fires or dust entrained by storms. While these may be of considerable importance on a global scale, it is the anthropogenic pollutants we are most concerned with in the urban environmental context. Emission of pollutants may be from fixed, mobile, point, lined or area sources.

In recent years, as the public has become increasingly concerned with environmental problems, air has come to be regarded as a resource within the public domains. Hence air pollution is concern not only of those who discharge the pollution, but also of those who may suffer as a result. In particular, air pollution is as issue of global concern as the problem is not restricted to boundaries of any single country or continents.

CHAPTER 2

ENVIRONMENTAL IMPACT ASSESSMENT (EIA)

CHAPTER 2

ENVIRONMENTAL IMPACT ASSESSMENT (EIA)

2.1 CONCEPT AND DEFINITION OF ENVIRONMENTAL IMPACT

Environment is the whole complex of physical, social, cultural, economic and aesthetic factors which affect individuals and communities and ultimately determine their form, character, relationship and survival. Thus "environmental impact" may be defined as any alteration of environmental conditions or creation of a new set of environment conditions, adverse or beneficial, caused or induced by the actions or set of actions under consideration. These impacts are identified and qualified for the prediction and assessment of impact on air environment. Impacts can be categorized as either primary or secondary. Project "inputs" generally cause primary impacts and project "output" generally causes secondary impacts. This distraction is important for consideration of alternatives and ways to minimize adverse impacts in performing an environmental impact analysis generally varies according to types of project, development, or action under evolution.

2.2 PURPOSE OF ENVIRONMENTAL IMPACT ASSESSMENT:

Environmental impact assessment is the key to providing information is support of the decision making process which is an objectives analysis conducted to identify measure there likely economic, social, aesthetic and environmental effects of the proposed action and the various reasonable alternatives. This requires the identification, measurements, and aggregation of the impact to provide “total” assessment. In context of air pollution, purpose of EIA is to predict the impacts of air pollution and also obtain data on existing pollution levels and therefore assess the impact on the air quality due to new or old both the sources.

2.3 STEPS INVOLVED IN PREDICTION AND ASSESSMENT OF IMPACT:

1) Identification of air pollutants from sources.
2) Basic level ambient air quality of the area determination.
3) Estimation of the air pollution dispersion potential with help.
   (a) Monthly variation of mean mixing depth.
   (b) Wind speed.
   (c) Inversion height.
   (d) High air pollution potential.
4) Collection of micro meteorological data, summaries, and rainfall pattern.
5) Identification of major air pollution sources.
6) Air quality standards or emission standards along with time required to meet them.
7) Estimations of impact caused by the project by various alternative methods.
8) Determination of ground level concentration of air pollutants from the alternative under varied meteorological conditions.

2.4 ASSESSMENT METHODOLOGY:

An air quality impact analysis must include the following five elements

1. Existing environment: A description of existing environment in the area of proposed project.
2. Environmental impact: A description of future year impact on the air quality as a result of completion and use of proposed project.
3. Mitigation procedures: A description of procedures that may be implemented to reduce degradation of the air quality associated with the proposed project.
4. Alternatives: A description charges in design of the project that may be adopted to reduce the degradation the air quality associated with the proposed project.
5. Growth inducing consideration: A description of growth inducing potentials of the proposed project and boundary impact on air quality resulting from the induced growth.

Methodologies selected should fulfill the requirement of such element mentioned above.

2.5 CRITERIA FOR SELECTION OF ASSESSMENT METHODOLOGY:-

Selection of methodologies depends on :

a) Source type and location.
b) Experience and engineering judgment.
c) Requirements of regulatory and review process.

2.6 INFORMATION REQUIRED FOR AIR QUALITY IMPACT ANALYSIS:

An air quality impact analysis must be founded upon appropriate and adequate information. Analyses are often based upon “available” information as it is not always readily available. Efforts should be made to utilize best available information.

CHAPTER 3

DISPERSION OF AIR POLLUTANTS

CHAPTER 3
DISPERSION OF AIR POLLUTANTS

Before going to the dispersion models it is important that we understand the factors that are responsible the dispersion of pollutants in the atmosphere. The factors that affect the transport, dilution, and dispersion of air pollutants can be grouped into:

- Emission or source characteristics
- The nature of the pollutant material
- Meteorological characteristics
- The effects of terrain and anthropogenic structures.

3.1 SOURCE CHARACTERISTICS

Most industrial pollution is discharged vertically from a stack or dust into the open air. As the contaminated gas stream is emitted the plume (body of polluted air) expands and plume means the body of pollution air, Wind that is horizontal air movement will bend the plum in the downwind direction. At some distance from the source, the plume will level off. While the plume is rising, bending and starting to move with the wind in the downwind direction the flue gas is being mixed and diluted by the ambient air. As the gas is being diluted by increasing volumes of air, the contaminate will eventually reach the ground. The initial rise of the plume is due to the upward inertia of the gas stream exiting the stack, and by its buoyancy. The vertical inertia is related to the exit velocity and mass of the gas. The buoyancy is related to the density relative to the surrounding air, primarily determination by temperature. Increasing exit velocity and increasing exit temperature will increase the plume rise.

3.2 NATURE OF POLLUTANT MATERIAL

If the particles are of the order of 20 micron or smaller in diameter, they have such a low setting velocity that they are essentially in the same manner as the gas in which they are immersed. Larger particles however cannot be treated in the same way, they have a significant settling velocity.

3.3 METEOROLOGICAL CHARACTERISTICS

The degree to which air pollutant discharged from various sources concentrate in a particular area depends largely on meteorological conditions. Even through the total discharge of contaminants into the atmospheric in a given area remains constant from day to day the degree of air pollution may very widely because of difference in meteorological conditions.

A. DOWNWIND DISTANCE

The greater the distance from the discharge point, the greater the volume of air available for dilution. However, since the plume starts above the ground and needs some time to reach the ground (by bending and spreading), there is no concentration observable in the immediate vicinity of the stack, then we can observe an increases for some distance as the plume approaches the ground. After this, the ground-level concentration will decreases with increasing distance from the emission source.

B .WIND SPEED AND DIRECTION

The wind direction will determine the direction in which the plume will move across local terrain. Wind speed affects the plume rise (fast wind will bend the plume faster), and will increases the rate of dilution.

C. ATMOSPHERIC STABILITY

The tendency of the atmosphere to resist or enhance vertical motion and thus turbulence is termed stability. Stability is related to both the charge of temperature with height (the lapse rate) and wind speed.

A natural atmosphere neither enhances nor inhibits mechanical turbulence. An unstable atmosphere enhances turbulence, where a stable atmosphere inhibits mechanical turbulence. The turbulence of the pollutant. The more unstable the atmosphere, the greater the dilution. Stability classes are defined for different meteorological situations, characterized by wind speed and solar radiation (during the day) and cloud cover during the night. Stability classes are defined for different meteorological situations, characterized by wind speed and solar radiation (during the day) and cloud cover during the night. The so called Pasquill Turner Stability Classes (based on D. Bruce Turners Workbook of Atmospheric Dispersion Estimates include six stability classes:

1. A : very unstable
2. B : unstable
3. C : slightly unstable
4. D : neutral
5. E : stable
6. F : very stable

D. MIXING HEIGHT

It is defined as that height above the earth's surface to which related pollution will extend, primarily through the action of atmospheric turbulence. It is usually related to one or more of the three factors wind direction, winds speed, and wind turbulence.

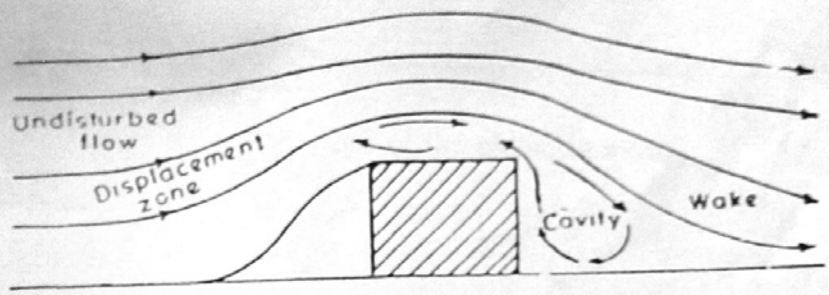
E .LAPSE RATE

It is defined as the vertical temperature gradient is given by T=-dz /dt in deg C/m. the different types of lapse rate are:

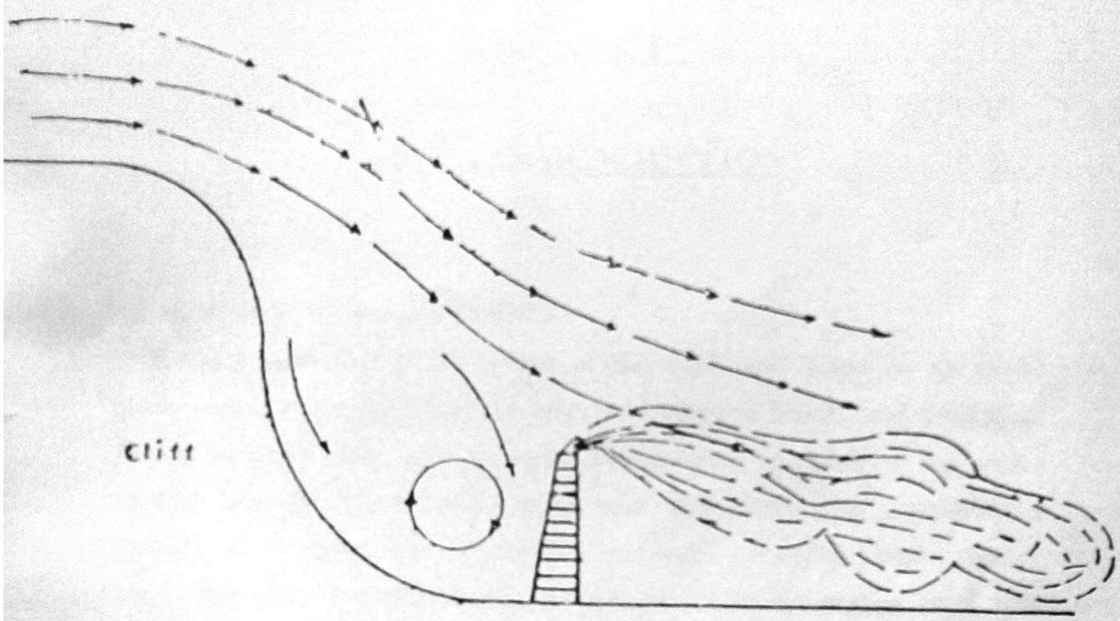
1. Environmental lapse rate : It is the actual lapse rate in the atmosphere.
2. Adiabatic laps rate: The laps rate of parcel of dry air as it moves upward in hydrostatically statically stable environment and expands slowly to lower environmental pressure without exchange of heat.
3. Saturated lapse rate: when a saturated air parcel changes elevation adiabatically, water vapor condenses. This condensation process releases the enthalpy of condensation from the water, and the result is the lowering of the temperature.
4. Negative Environmental lapse rate (Inversion): It is the condition in the atmosphere in which air temperature increases with elevation. Under this condition, the atmosphere is said to be in stable condition. The different types of inversion are:
    a. Radiation Inversion: It usually occurs at night, when the earth loses heat by radiation and cools the air in contact with it.
    b. Subsidence Inversion: It occurs at modest altitudes and often remains foe several days. It is caused by sinking or subsiding of air in anti-cyclone. As the air sinks, it is compressed and gets heated to form a warm dense layer, which acts as a lid to prevent the upward movement of contaminants.
    c. Drainage inversion: Nighttime flow of cold air down the valleys often leads to inversion at the bottom of the valley, with cold air flowing in under warmer air. If condensation results, forming a fog, then the sun cannot get to the ground during the day and the inversion will persist for days units a major storm cleans it out.

3.4 TERRAIN EFFECT:

If an industry is located close to a barrier like mountain then it will disturb the airflow a great deal and can make a plume behave differently from from what one would predict from the Gaussian equation. This will be results in high ground level concentration in the windward side known as Aerodynamic Downwards. Downwash is a situation during which a plume emitting from a stack located in a deep valley is carried to the ground when the wind over a cliff as shown in the figure.



Wind flow field around a sharp-edged building.



Behaviour of the plume in a valley.

A plume may also get sucked into a low pressure wake behind a building. Leading to a high local concentration. This wake is caused by the wind flowing over the building. The simple rule for avoiding this problem is to make the stack height at least 2.5 times the height of the tallest nearby building.

CHAPTER 4

PROCESS DESCRIPTION

CHAPTER 4

PROCESS DESCRIPTION

4.1 HISTORICAL BACKGROUND:

Rourkela steel plant (RSP) is one of the three steel plants set up in the public sector in the late fifties, the other two being at Bhilai and Durgapur. Among the three RSP was the only one designed to produce flat rolled products such as hot or cold rolled coils and sheets. The original annual capacity of the plant was 1.0 million tone ingot steel. The plant capacity was subsequently expanded during the mid sixties to 1.8 million ingot tons per year. High quality products such as galvanized sheets and electrolytic tine plates were added to the product mix during the expansion. This plant has the distinction of being among the early applicators of the LD process of steel making on a commercial basis.

4.2 PRESENT PROCESS TECHNOLOGY OF STEEL MANUFACTURING

The plant uses conventional blast furnaces for producing hot metal. The coke required for the blast furnace operation is produced in conventional coke oven batteries. The by products from the coking process are recovered in a plant attached to the coke oven section. The hot metal is smelted to different qualities of steel. The smelting is largely in basic oxygen vessels (LD converters) and balance in fuel fired open hearth furnaces, more commonly in use at the time of the initial installation. The converters are lined with dolomite bricks using calcined dolomite produced in a rotary kiln Lime required for fluxing is produced in vertical shaft kilns. The steel so produced is cast into ingots, which are taken to a slabbing cum blooming mill for conversion into slabs. These slabs form the starting material for further conversion to hot rolled coils and plates. A sizeable part of the hot rolled coils are in turn converted to various products in further downstream units such as the cold rolling mill complex, the pipe plants and the silicon steel plant, which produces cold rolled grain oriented and non grain oriented silicon steel sheets. A fertilizer plant was also installed initially to produced calcium ammonium nitrate utilizing hydrogen from coke oven gas from the plant's coke ovens, nitrogen from the plant's air separation units and also some cracked naphtha purchased from outside.

The main saleable products of RSP are:

- Heavy plates
- Hot rolled coils
- Hot erolled plates
- Hot rolled sheets
- Cold rolled coils
- Cold rolled sheets
- Hot deep galvanized sheets
- Electrolytic tin plates
- Hot rolled electrical sheets
- ERW pipes
- Spirally welded pipes
- Cold rolled grain oriented silicon steel sheets
- Cold rolled non grained oriented silicon steel sheets
- Pig iron
- By products from coke ovens
- Calcium ammonium nitrate

4.3 THE TECHNOLOGY OF POWER GENERATION

A thermal power station using steam as working fluid works basically on the Rankine cycle. Steam is generated in a boiler, expanded in the prime mover and condensed in condenser and fed into the boiler again. However, in practice, there are numerous modifications and improvements in this cycle with the aim of affecting heat economy and to increase the thermal efficiency of the plant.

Coal received in coal storage yard of power station is transferred to the furnace by coal handling equipment. Heat produced due to burning of coal is utilized in converting water contained in the boiler drum into steam at suitable pressure and temperature. The steam generated is passed through the super heater. Super heated steam then flows through the turbine. After doing work in the turbine the pressure of the steam is reduced. Steam leaving the turbine passes through the condenser which maintains the low pressure steam at the exhaust of the turbine. Steam pressure in the condenser depends upon the flow rate and temperature of cooling water and on effectiveness of air removal equipment. Water circulating through the condenser generally taken from the various sources such as rivers, or lakes etc. in case of non-availability of sufficient quantity of water, the hot water coming out of the condenser can be cooled in colling towers and circulated again through the condenser. Bled steam taken from the turbine at suitable extraction points is set to low pressure and high pressure water heaters. Air taken from the atmosphere is first passed through the air preheated, where it is heated by the gases. The hot air then passes through the furnace. The flue gas after passing over boiler and super heater tubes, flow through the dust collector, economizer, and air preheated at various stages and finally exhausted to the atmosphere through the chimney.

The main components in thermal power plant are:

a. **Intake pump house:**

This houses pumps to draw the total raw water requirement of the plant.

b. **Water treatment plant:**

This clarifies raw water to feed the DM plant and meet other requirements of cooling water. Present day installation clarifies the total raw water less the fire fighting water requirement.

c. Demineralizer plant:

This demineralizes the clarified water for feed to boiler, cooling etc. as make up water.

d. Cooling Tower:

This cools the recalculating condenser cooling water where once through cooling or pond cooling is not feasible or it inadequate

e) C.W. Pump house

This houses the circulating water pumps circulating the cooling water through the condenser and the cooling water through the condenser and the cooling tower where provided.

f) **Coal Handling Plant:**

It receives raw coal, unloads, stores, reclaims, crushes, and feeds to the boiler raw coal bunker in the main building.

g) **Ash handling plant:**

It extracts coal ash from hoppers, conveys and discharges to disposal area or ash silos.

h) **Fuel oil handling plant:**

This comprises of large oil storage tanks, oil wagon unloading facilities and a pump house for pumping oil from storage tanks to boiler house.

i) **Boiler and Auxiliaries:**

It converts chemical energy in fuel to heat energy in steam.

j) **Turbine and Auxiliaries:**

It converts heat energy in steam to kinetic energy through controlled expansion in stages and drives and generator.

k) **Generator and Auxiliaries:**

Coupled to the turbine, it transforms kinetic energy to electric energy.

l) **Transformers:**

Electrical power produced is stepped up in voltage through transformer and fed to the grid system. Start up and reserve auxiliary power is availed from the system or other sources trough step down transformer. In normal operation TG units supply their own auxiliaries through unit auxiliary transformers tapped from generator terminal or bus duct. All these transformers and located outside the main building front wall. Smaller auxiliary supply transformers and spread over the plant area.

m) **Switchyard:**

This connects the power station to the power system for power evacuation.

n) **Instrumentation and control:**

All inputs and intermediate and final products are controlled and measured in very stage of the process with parameters indicated, recorded and automatically adjusted to set values.

o) **Compressor house:**

This houses the services compressors required for pneumatic operated equipments and valves and the instrument air compressors for the pneumatic system instrumentation.

p) **Miscellaneous Pumps:**

These are the bearing cooling water pumps, services water pumps, lubricating oil pumps, drainage pumps, colony water supply pumps, chemical dozing pumps and the like.

q) **Stack:**

This throws the builder discharge gas up in the atmosphere to minimize dust concentration in the vicinity and adds to the draft.

r) **Environmental control**

Provision of EP for dust extraction, tall stack, recycling of ash water, treatment of oil and chemical effluents before discharge and sewage treatment are required. Plantation of trees and socioeconomic upliftment of neighboring population are essential part of such work. Flora and fauna and wild life are to be preserved.

s) **Fire Fighting system:**

Separate electric motor driven and diesel engine drive fire water pumps with storage tanks and water mains running through all operation area, multi fire engines in the plant area round the clock manning are part of the system.

t) **Laboratory:**

A set of laboratories for oil, water, coal analysis, relay and instrument testing, communication equipment testing, soil and concrete testing, radiography and weld test, vibration analysis, metallurgical test is provided.

u) **Workshops:**

Workshops for electrical repair and maintenance, machining and fabrication work are provided. A motor vehicle repair shop is also included.

v) **Heavy Repair Shop:**

This shop provides maintenance to dozers, dumpers, cranes, locos (separately) mainly required in coal handling ash handling and heavy maintenance work.

w) **Stores:**

A set of stores both open and closed with rail siding facility is erected .

x) **Ancillary Facilities:**

Facilities like security posts at gates and in vulnerable area, round the clock manned first-aid posts, safety check units, canteen, and time office are other service requirement.

CHAPTER 5

IMPACT OF AIR POLLUTION

CHAPTER 5
IMPACT OF AIR POLLUTION

The variety of matter emitted into the atmosphere by nature and anthropogenic sources is so diverse that it is difficult to classify air pollutants neatly. However, usually they are divided into two categories of primary and secondary pollutions. The primary pollutants are those that are emitted directly from the source and the secondary pollutants are those that are formed in the atmosphere by chemical interactions among primary pollutants and normal atmospheric constituents. Of the large number of primary pollutants emitted into the atmosphere, only few are present in sufficient concentration to be of immediate concern. Theses are the five major types. Particulate matter, sulphur dioxide, oxides of nitrogen, carbon monoxide and hydrocarbons. Of the five major types the first three are of major concern with environment pollution, therefore the effects and preventive measures taken for the first three are discussed in detail.

5.1 PARTICULATES:

Particulate air pollution includes:

- Smoke …….fine carbon particles from combustion
- Dust ……….from crushing and grinding etc.

- ❖ Fumes………created when solids are volatilized by high temperature and condensed less than 1 micron.
- ❖ Mist…………formed when vapour condensed or through chemical reaction.

5.1.1 EFFECT ON HEALTH:

Concentration $\mu g/m^3$	**Accompanied by SO_2**	**Time**	**Effect**
750	715 $\mu g/m^3$	24 – hr average	Considerable increase in illness.
300	630 $\mu g/m^3$	24 – hr average	Acute worsening of chronic bronchitis patients.
200	250 $\mu g/m^3$	24 – hr average	Increased absence of industrial workers
100-130	120 $\mu g/m^3$	Annual mean	Increased incidence of disease in children
	Sulfation rate above 30 mg/cm2 mo	Annual mean	Increased death rate for those over 50 likely
80-100	…….do………	2- yr mean	Increased death rate for those 50-69 yrs.

5.1.2 PARTICULATE EMISSION CONTROL

1. BAG FILTER

It is form of a tubular medium made of woven or felted fabric. The diameter of bag is 1 m and height is 7 m to 10 m. it has got the collecting efficiency of 99%. The bags are connected to a dust hopper fitter with discharge device. It is necessary to have low gas velocities of the order of about 1 to 3 m per minute.

2. **CYCLONE COLLECTOR:**

The effluent gases flow through a light circular spiral which produces centrifugal force on the suspended particles which in turn are forced to move outward through the gas stream gets collected. This device has the efficiency of 95% removal for the particulates having the size varying from 5μ to 10μ.

3. **ELECTROSTATIC PRECIPITATOR:**

It work on the principle that when the particles move through a region of high electric potential, they become charged and then they are attracted to an oppositely charged area where they are collected and removed. It can be operated at a high temperature at efficiency of about 95 to 98%.

4. **WET SCRUBBER:**

Theses are the collecting devices in which the particles are washed out of the gas flow by a water spray. Extreme care should be taken to see that the collected wastewater does not become a source of water pollution. It requires special settling tanks, chemical flocculation or filtration units.

5.2 SULPHUR DIOXIDE (SO_2)

The pollution of air by sulphur dioxide (SO_2) is widespread because it exists wherever fossil fuels are burnt. The largest contribution of (SO_2) is from the thermal power stations. The oxides of sulphur emitted in air are potentially harmful because of their following effects.

1. They are harmful to stones and marble works.
2. They can cause damage to plant tissues.
3. They promote corrosion of metal works.

5.2.1 EFFECTS OF SO_2 ON HUMANS:

Concentration (ppm)	Effects
0.2	Lowest concentration causing a human response
0.3	Threshold for taste recognition
0.6	Threshold for odor recognition
1.6	Threshold for inducing reversible broncho-constriction in healthy
8-12	Immediate throat irritation
10	Eye irritation
20	Immediate coughing

5.2.2 OPTIONS FOR REDUCTION OF EMISSION:

Besides using fuels low in sulphur contents, three possible methods or alternative individually or in combination may be used to reduce sulphur dioxide emission from fuel combustion. These are:

(a) Use of tall stacks to increase atmospheric dispersion.
(b) Removal of sulphur from solid fuel
(c) Cleaning of combustible gases from hydrogen sulphide.
(d) Flue gas purification from lime or limestone.
(e) Flue- gas desulphurization.

5.3 NITROGEN OXIDES (NO_x)

The nitrogen oxides result from air oxidation, electrical discharge and solar radiations. The high temperature process like welding operation, steam generating equipments, smelting and other metallurgical operations etc yield oxides of nitrogen.

5.3.1 EFFECTS OF NO_x:

1. Acid rains
2. Toxin and produce a sharp irritating effects, specially on mucus membrane of eyes.
3. Poorly soluble in liquid and can penetrate deep into lungs.
4. Even at low concentration can reduce respiratory functions.
5. Nitrogen oxide in concentration of 4-6 mg/m3 can cause heavy injuries to
6. Low concentration through being apparently harmless for plants can inhibit
7. Their growth.
8. Promote the formation of smog and reduce visibility.

5.3.2 EFFECTS OF NO_2 IN HUMANS:

Effects	No_2 conc. (ppm)	Exposure
Increased in acute respiratory disease.	0.06-1	2-9-3 years
Increased in acute bronchitis in school children	Up to 0.1	6 months
Human olfactory threshold	0.12	< 24 hrs
Increased in airway resistance	5.0	10 min
Pulmonary edema	90	90

5.3.3 OPTION FOR REDUCTION:

A major method employed in NO_x control is flue gas recirculation. A portion of cooled flue gas is injected back into the combustion zone. This additional gas acts as a thermal sink and reduces the overall combustion temperature. Recently developed fluidized bed boilers are known to produce about one half the NO_x that is emitted by conventional boilers firing pulverized coal. Other method includes application of special burner into two-stage combustion, injection of water and stream into combustion zone, etc.

CHAPTER 6

AIR QUALITY MODELING

CHAPTER 6
AIR QUALITY MODELING

Models are used in all aspects of air quality planning where predication is a major component from episode forecasting to long term planning. It also allow us to predict the concentration that would results from any specified set of pollutant emission for any specified meteorological conditions, at any location, for any time period, with total confidence in our predication. The best currently available models are from this idea.
As measurement technology, computer technology and knowledge of atmosphere and the process that takes placer in the atmosphere and have been improved, theses models have more and more computer models in order to meet the requirements of mathematical modeling following points are to be considered.

i. Meteorological; data utilized wherever available or the analysis is modified it either is not possible. It is regarded to collect meteorological data.
ii. Source data is not possible. It is regarded to collect meteorological data.
iii. The background air quality data is collected and if not available the same may be monitored.

6.1 DIFFERENT TYPES OF AIR QUALITY MODELS:

6.1.1 BOX MODEL: It consider that pollutants are emitted into a volume of air in space of an imaginary base having depth D, width W and infinite length.

ASSUMPTIONS:

1. Atmospheric turbulence produces complete and total mixing of pollutants up to the mixing height H and no mixing above this height.
2. The turbulence is strong enough in the upwind direction that pollutant concentration is uniform in the whole volume of air over the city and not higher at the down wind side than upwind side.
3. The concentration of pollutant entering the city is constant.
4. The velocity is constant and independent of time, location and elevation above the ground. Taken average of ground level and at height H.

Considering the assumption at steady state condition accumulation rate is zero

All flow rate in = all flow rate out

$$C_j = Q_j / UWD$$

Where

C_j = concentration of pollutant species in gm/m3

Q_j = emission rate of pollutants in gm/ sec.

W = width of the box normal to

D = depth of the box normal to wind direction in m.

ADVANTAGES:

Great simplification in its application. It reminds us that a limited resource of air available for diluting pollutants. It tells us that the concentration will increases as the volume of air is reduced or as emission rate is increases. Although the box model is not usually acceptable for formal air quality analysis, it is useful for qualitative estimates of source impact.

DISADVANTAGE:

It can’t account for dispersion of pollutants laterally and vertically.

6.1.2 DISPERSION MODEL:

These models are formulated from fundamental differential equation governing the conservation species. They are more appropriate for prediction of air quality because theses models consider the point-by-point transport, dispersion, generation and removal of pollutants species and provide for spatial temporary variation of theses processes.

6.1.3 GAUSSIAN PLUME MODEL:

Box models and proportion models lacking in reality. They fail to account for dispersion of pollutants in atmosphere. Computational model most often arrive by deductive arguments at mathematically formulas, which need first an adequate amount of meterological input above the state of atmosphere (wind velocity and direction thermal stability, turbulence etc). Gaussian plume concept and formula (model) is one example of computational modes in which if and when the exact conditioned specified by parameters occur (perhaps the most important cases are when wind direction is correctly specified, when plume rise formula which nearly app. The real situation is used or when the stability is evaluated correctly) then Gaussian plume formulas will give fair approximation of the isopleths contours and the orders of magnitude of the concentration be expected. But how often and for how long the given set of parameters appears in the surrounding is beyond Gaussian concept.

GAUSSIAN DISPERSION MODEL – GROUP LEVEL POINT SOURCE

$C_{j\ (x,y,z)} = Q_j / (s_y p U s_z) \exp[-y^2 /2 (s_y)^2 - (z_2/ 2 (sz)^2)]$

GAUSSIAN DISPERSION MODEL –ELEVETED POINT SOURCE

$C_{j\ (x,y,z)} = Q_j / (U s_y s_z p) \exp[-y^2 /2 (s_y)^2 \{ \exp [Z-H)^2/2(sz)^2] + \exp [(Z+h)^2 / 2 (s_z)^2]\}$

GAUSSIAN DISPERSION MODEL –GROUND LEVEL LINE SOURCE

$C_{j\ (x,z)} = 2Q_j L[\exp(-Z^2/2(s_z)^2](2p)^{1/2} U s_z$

Where

Q_j = emission rate of pollutants species in gm/sec.

S_z = vertical Gaussian dispersion coefficient in m.

S_y = horizontal Gaussian dispersion coefficient in m.

U = wind in x- direction in m/sec.

H = height of the elevated source in m.

L = length of line source in m.

6.2 DISPERSION CO-EFFICIENTS:

The modal requires information on values of dispersion co-efficient (s_y, s_z) and the variation of theses co-efficient with atmospheric stability class and downward distance. Hence different set of (s_y,s_z) variable has been developed.

6.2.1 Brigg's equations for various stability class for dispersion coefficients:

Required stability class	S_y (meters)	S_z (meters)
A	$0.22x\,(1+0.0001\,x)^{-1/2}$	$0.2x$
B	$0.16x\,(1+0.0001\,x)^{-1/2}$	$0.12x$
C	$0.11x\,(1+0.0001\,x)^{-1/2}$	$0.08x\,(1+0.0002x)^{-1/2}$
D	$0.08x\,(1+0.0001\,x)^{-1/2}$	$0.06x\,(1+0.0015\,x)^{-1/2}$
E	$0.06x\,(1+0.0001\,x)^{-1/2}$	$0.03x\,(1+0.0003\,x)^{-1/2}$
F	$0.04x\,(1+0.0001\,x)^{-1/2}$	$0.016x\,(1+0.0003\,x)^{-1/2}$

6.3 PASQUILL'S STABILITY CATEGORIES:

Formalize the relation between atmosphere surface stability and those factors controlling stability isolation nocturnal radiation and meteorology. This classification is done in accordance with the wind speed and incoming solar radiation for a day or down cover for night.

6.3.1 PASQUILL'S chart:

Surface wind speed (m/s)	**Day incoming Radiation**			**Night cloud conditions**	
	Strong	**Moderate**	**Slight**	**Thinly overcast 4/8 low cloud**	**3/8 low cloud**
2	A	A-B	B	….	….
2-3	A –B	B	C	E	F
3-5	B	B –C	C	D	E
5-6	C	C –D	D	D	D
>6	C	D	D	D	D

Neutral class D should be assumed for overcast conditions during day or night.

Stability class	**Class description**
A	Extremely stable
B	Unstable
C	Slightly unstable
D	Neutral
E	Slightly stable
F	Stable to Extremely stable

6.4 Effective stack height (He):

He = h_o + plume rise

Where

He = effective stable height which is height from ground level at which the pollutant is emitted into atmosphere from the stack.

H_o = stack height in m.

Plume rise:

It is defined as the vertical motion of a plume from an elevated source to the height when it becomes horizontal. The rise is a result of momentum and thermal forces. Momentum forces results from vertical velocity of stack gases that give upwardly directed momentum. The thermal process result from the buoyancy of effluent gases, when stack gas exhaust temperature exceeds surrounding ambient temperatures.

Brigg's plume rise equation:

a) For stable conditions (viz E,F):

$X < 2US^{-1/2}$, plume rise = $1.6 F^{1/3} X^{2/3}/U$

$X < 2US^{-1/2}$, plume rise = $2.9 (F/ US)^{1/3})$

b) for unstable and neutral conditions (viz, A,B,C, D):

$X<=3.5 Xd$, plume rise = $1.6 F^{1/3} Xd^{2/3})/U$

Where

S= stability factor = 9.8 [Tg +0.98]/Ta

F = buoyancy factor in m4 / sec3

= gVsD2 [(Ts-T3)/Ts]/4

D = internal stack diameter in m.

Vs = exit gas velocity in m/sec.

U = mean wind speed at height of emission from stack in m/sec.

Ts = stack gas exit temperature, degree Kelvin.

T_3 = ambient atmospheric temperature in degree Kelvin.

X = distance of receptor from source in m.

Xd = 14 F 5/8 (F,55)

Or 34 F 2/5 (F, 55)

CHAPTER: 7

AIR IMPACT MODELLING

(PROGAMMING)

```
#include<iostream.h>
#include<stdio.h>
#include<conio.h>
#include<math.h>
#include<process.h>
#include<graphics.h>
#include<dos.h>
#include<stdlib.h>
#include<string.h>

struct stack
        {
          double vs,d,u,p,ts,ta,hg,h;
          double vsn,dn,un,pn,qhn,hn;
          double vss,ds,us,ps,qhs,hs;
          double vsu,du,uu,pu,qhu,hu;
        }so;
float general();
float neutral();
float subadia();
float superadia();
float valueH(float);
void point(float,float);


void main()
{
 float g,h,n,s,u,hpg,hpn,hps,hpu;
 int ch=0;
 clrscr();
while (ch!=5)
{
cout<<"\n\t\t\t EFFECTIVE HEIGHT EQUATION";
cout<<"\n\t\t\t---------------------------";
cout<<"\n\n\n\n\n1:GENERAL";
cout<<"\n2:NEUTRAL";
cout<<"\n3:SUBADIABATIC";
cout<<"\n4:SUPER ADIABATIC";
cout<<"\n5:EXIT";
cout<<"\n\n ENTER YOUR CHOICE:-";
cin>>ch;
```

```
if(ch==1)
{
g=general();
hpg=valueH(g);
point(g,hpg);
exit(0);
}
if(ch==2)
{
n=neutral();
hpn=valueH(n);
point(h,hpn);
exit(0);
}
if(ch==3)
{
s=subadia();
hps=valueH(s);
point(s,hps);
exit(0);
}
if(ch==4)
{
u=superadia();
hpu=valueH(u);
point(u,hpu);
exit(0);
}
if(ch==5)
{
exit(0);
}
}
}
float general()
{
clrscr();
cout<<"\n\t\t\t GENERAL:";
cout<<"\n\t\t\t---------";
cout<<"\n\nEnter stack velocity in m/sec(Vs):-";
cin>>so.vs;
cout<<"\nEnter stack diameter in m (D):-";
cin>>so.d;
cout<<"\nEnter wind speed in m/sec(u):-";
cin>>so.u;
cout<<"Enter pressure in millibars(P):-";
```

```
cin>>so.p;
cout<<"\nEnter stack gas temperature in kelvin(Ts):-";
cin>>so.ts;
cout<<"\nEnter air temperature in kelvin(Ta):-";
cin>>so.ta;
so.hg=((so.vs*so.d)/so.u)*((1.5+(2.68*(1/pow(10,3))*so.p*so.d)*((so.ts-so.ta)/so.ts)));
cout<<"\nPLUME RISE IN GENERAL CASE:";
cout<<so.hg;
return(so.hg);
}

float neutral()
{
clrscr();
cout<<"\n\t\t\tNEUTRAL STABILITY:";
cout<<"\n\t\t\t------------------";
cout<<"\n\n\n\n\nEnter stack exit velocity in m/sec(Vsn):-";
cin>>so.vsn;
cout<<"\nEnter stack diameter in m(Dn):";
cin>>so.dn;
cout<<"\nEnter wind speed in m/sec(Un):-";
cin>>so.un;
cout<<"\nEnter stack heat(Qn):-";
cin>>so.qhn;
so.hn=((0.35*so.vsn*so.dn)/so.un)+(2.64*(pow(so.qhn,.5)/so.un));
cout<<"\nPLUME RISE FOR NEUTRAL STABILITY:";
cout<<so.hn;
return(so.hn);
}


float subadia()
{
clrscr();
cout<<"\n\t\t\tSUB ADIABATIC:";
cout<<"\n\t\t\t--------------";
cout<<"\n\n\n\n\nEnter stack exit velocity in m/sec(Vssub):-";
cin>>so.vss;
cout<<"\ENTER STACK DIAMETER IN m(Dsub):-";
cin>>so.ds;
cout<<"\nEnter wind speed in m/sec(Usub):-";
cin>>so.us;
cout<<"\nEnter stack heat(Qhs):-";
cin>>so.qhs;
so.hs=(2.24*(pow(so.qhs,.5)/so.us))-((1.04*so.vss*so.ds)/so.us);
cout<<"\nPLUME RISE FOR SUBADIABATIC:";
```

```
cout<<so.hs;
return(so.hs);
}


float superadia()
{
clrscr();
cout<<"\n\t\t\tSUPER ADIABATIC:";
cout<<"\n\t\t\t----------------";
cout<<"\n\n\n\n\nEnter stack exit velocity in m/sec(Vsu):-";
cin>>so.vsu;
cout<<"\nEnter stack diameter in m(Du):-";
cin>>so.du;
cout<<"\nEnter wind speed in m/sec(Uu):-";
cin>>so.uu;
cout<<"\nEnter stack heat(Qhu):-";
cin>>so.qhu;
so.hu=((3.47*so.vsu*so.du)/so.uu)+(5.15*(pow(so.qhu,0.5)/so.uu));
cout<<"\nPLUME RISE FOR SUPERADIABATIC :-";
cout<<so.hu;
return(so.hu);
}

float valueH(float a)
{
float H,hp;
cout<<"\n\n\n\nTO FIND THE EFFECTIVE STACK HEIGHT";
cout<<"\n------------------------------------";
cout<<"\n\n\nEnter the value of of physical height";
cin>>hp;
H=hp+a;
cout<<"The value of effective stack height(H):-";
cout<<H;
return(H);
}


/*  FUNCTION DECLARATION  */
char sclassd();
char sclassn();
float sws;
char sr;
int nc;
int main()
{
```

```
//FILE *fpt;
float d[12],ht[12],vs[12],ta[12],ts[12],dx[12][10],tg[12],f[10],rin,maxx[12],maxy[12];
float s[12],ran[12],pr[12][10],u[12],eht[12][10],x[10],x1[10],x2[10];
float y[10],y1[10],y2[10],ax,sigy[20][10],sigz[20][10],rl[10][10];
float ay,t1,t2,bm[9],beht[9][10],xd[10],er[9][2],bg[12];
char sc,nam[5][10],dn,ni[30],seas[10],loc[10],wid[10],cat,std[12][10][10][10];
int nos,xs,ys,nop,countx,county,countp,counts,i;
float conc[9][2][7][10],max[12],tconc[2][10][10];
clrscr();
/* GENERAL ASPECT OF INDUSTRY FOR THE REPORT ONLY */
printf("/n enter the catesory of the area :\nI:Industry ans mixed use\nR:Residential and
rural\nsensitive(hills,etc)");
fflush(stdin);
scanf("%c",&cat);
printf("\nEnter the name of industry:\n");
scanf("%s",ni);
printf("\nEnter the location of industry->");
scanf("%s",loc);

printf("\nEnter the no of stacks in the area->");
scanf("%d",&nos);

printf("\nEnter the no pollutents->");
scanf("%d",&nop);

for(countp=1;countp<=nop;countp++)
{
printf("\nEnter the name of pollutant %d",countp);
scanf("%s",nam[countp]);
printf("\nEnter the backgroundvalue of the pollutant %s ",nam[countp]);
scanf("%f",&bg[countp]);
}
printf("\nleft moststack is origin .Wind direction is X-axix");
for(counts=1;counts<=nos;++counts)
{
printf("\nEnter the co cards of stack %d ",counts);
scanf("%f %f",&x1[counts],&y1[counts]);
}
printf("\nEnter the no of points in the downwind direction ,X->");
scanf("%d",&xs);
printf("\nEnter the time of day as day or night \n");
fflush(stdin);
scanf("%c",&dn);
printf("\nEnter the name of season\n");
scanf("%s",seas);
printf("\nEnter the prevailing max wind direction as,N,S,.W,NE,SE,SW,NW ");
```

```
scanf("%s",wid);
if(dn=='n')
sc=sclassn();
else
sc=sclassd();
for(counts=1;counts<=nos;counts++)
{
printf("\nEnter the data asked for stack no. %d\n",counts);
printf("========================================================
=======================\n");
printf("Enter the internal diameter of the stack in m\n");
scanf("%f",&d[counts]);
printf("\nEnter the exit velocity in m/s\n");
scanf("%f",&vs[counts]);
printf("\nEnter the stack height in m\n");
scanf("%f",&ht[counts]);
printf("\nEnter the mean wind speed at height of emision from stack in m/s:");
scanf("%f",&u[counts]);
printf("\nEnter the stack gas exit temprature indeg.K\n");
scanf("%f",&ts[counts]);
printf("\nEnter the ambient temprature in deg.K\n");
scanf("%f",&ta[counts]);
printf("\nEnter the atmospheric temprature gradient in deg/100 m\n");
scanf("%f",&tg[counts]);
f[counts]=9.81*vs[counts]*d[counts]*d[counts]*(ts[counts]-ta[counts])/(4*ts[counts]);
s[counts]=9.81*(tg[counts]+0.98)/ta[counts];
if(f[counts]<55.0)
xd[counts]=14*pow(f[counts],0.625);

else
xd[counts]=34*pow(f[counts],0.4);

x[1]=500;

/* PLUME RISE CALCULATION STARTS */
for(countx=1;countx<=xs;++countx)
{
x2[countx]=x[countx]-x1[counts];

if(x2[countx]>0)
{
if((sc=='e')||(sc=='f'))
{
if(x2[countx]<=2*u[counts]*pow(s[counts],-0.5))
pr[counts][countx]=1.6*pow(f[counts],0.33)*pow(x2[countx],0.67)/u[counts];
else
```

```
{
ran[counts]=f[counts]/(u[counts]*s[counts]);
pr[counts][countx]=2.9*(pow(ran[counts],0.33));
}
}
else if(x2[countx]<=3.5*xd[counts])
{
pr[counts][countx]=1.6*pow(f[counts],0.33)*pow(x2[countx],0.67)/u[counts];
}
else
{
if(x2[countx]>3.5*xd[counts])
pr[counts][countx]=1.6*pow(f[counts],0.33)*pow(3.5*xd[counts],0.67)/u[counts];
}
eht[counts][countx]=ht[counts]+pr[counts][countx];
printf("\nEffective height of stack %d for point %d->
%f",counts,countx,eht[counts][countx]);
}
x[countx+1]=x[countx]+500;
}
}
/* PLUME RISE CALCULATION IS OVER */
/* CALCULATION OF DISPERSION COEFF STARTS */
x[1]=500;
for(counts=1;counts<=nos;++counts)
{
for(countx=1;countx<=xs;++countx)
{
x2[countx]=x[countx]-x1[counts];
if(x2[countx]>0)
{
ax=1+0.0001*x2[countx];
if(sc=='a')
{
sigy[counts][countx]=0.22*x2[countx]*pow(ax,-0.5);
sigz[counts][countx]=0.2*x2[countx];
}
else if(sc=='b')
{
sigy[counts][countx]=0.16*x2[countx]*pow(ax,-0.5);
sigz[counts][countx]=0.12*x2[countx];
}
else if(sc=='c')
{
sigy[counts][countx]=0.11*x2[countx]*pow(ax,-0.5);
ay=1+0.0002*x2[countx];
```

```
sigz[counts][countx]=0.08*x2[countx]*pow(ay,-0.5);
}
else if(sc=='d')
{
sigy[counts][countx]=0.08*x2[countx]*pow(ax,-0.5);
ay=1+0.0015*x2[countx];
sigz[counts][countx]=0.06*x2[countx]*pow(ay,-0.5);
}
else if(sc=='e')
{
sigy[counts][countx]=0.06*x2[countx]*pow(ax,-0.5);
ay=1+0.0003*x2[countx];
sigz[counts][countx]=0.03*x2[countx]*pow(ay,-1);
}
else
{
sigy[counts][countx]=0.04*x2[countx]*pow(ax,-0.5);
ay=1+0.0003*x2[countx];
sigz[counts][countx]=0.016*x2[countx]*pow(ay,-1);
}
printf("\nsigy %d %d=%f,\nsigz %d
%d=%f",counts,countx,sigy[counts][countx],counts,countx,sigz[counts][countx]);
}
else
{
sigy[counts][countx]=0.0;
sigz[counts][countx]=0.0;
}
x[countx+1]=x[countx]+500;
}
}
/* CONCENTRATION CALCULATION */
/**********************************************/
ys=xs+1;
for(county=1;county<=ys;++county)
{
for(countx=1;countx<=xs;++countx)
{
printf("\nEnter the terrian conditions i.e. inputthe R.L. of ground at this point%d ,%d
with respect to bench mark",countx,county);
scanf("%f",&rl[county][countx]);
}
}
for(counts=1;counts<=nos;++counts)
{
printf("\nEnter the R.L. of ground from bench mark from stack %d",counts);
```

```
scanf("%f",&bm[counts]);
for(countp=1;countp<=nop;countp++)
{
printf("\nEnter the emittiion rate for %s pollutant from stack no
%d",nam[countp],counts);
scanf("%f",&er[counts][countp]);
y[1]=0;
for(county=1;county<=ys;++county)
{
for(countx=1;countx<=xs;countx++)
{
x2[countx]=x[countx]-x1[counts];
y2[county]=y[county]-y1[counts];
if(x2[countx]>0)
{
/*  TERRIAN CONDITIONS */
/****************************************************************/
beht[counts][countx]=bm[counts]+eht[counts][countx];
if(rl[county][countx]<beht[counts][countx])
{
rin=pow((beht[counts][countx]-rl[county][countx]),2);
t1=exp(-(y2[county]*y2[county])/(2*pow(sigy[counts][countx],2)));
t2=exp(-(rin)/(2*pow(sigz[counts][countx],2)));
conc[counts][countp][county][countx]=(er[counts][countx])*t1*t2/(2.0*3.14*u[counts]*s
igy[counts][countx]*sigz[counts][countx])*1000.0*1000.0;
}
else
{
t1=exp(-(y2[county]*y2[county])/(2*pow(sigy[counts][countx],2)));
conc[counts][countp][county][countx]=(er[counts][countp]*t1)/(3.14*sigy[counts][count
x]*sigz[counts][countx]*u[counts])*pow(10,6);
}
}
else
conc[counts][countp][county][countx]=0;
x[countx+1]=x[countx]+500;
}
y[county+1]=y[county]+50;
}
}
}
/*  TOTAL CONCENTRATION AT A POINT    */
for(countp=1;countp<=nop;countp++)
{
max[countp]=0;
for(county=1;county<=ys;county++)
```

```
{
for(countx=1;countx<=xs;++countx)
{
tconc[countp][county][countx]=bg[countp];
for(counts=1;counts<=nos;++counts)
{
tconc[countp][county][countx]=tconc[countp][county][countx]+conc[counts][countp][co
unty][countx];
}
if(max[countp]<tconc[countp][county][countx])
{
max[countp]=tconc[countp][county][countx];
maxx[countp]=x[countx];
maxy[countp]=y[county];
}
x[countx+1]=x[countx]+500;
}
y[county+1]=y[county]+50;
}
}


/* AMBIENT AIR QUALITY STANDARDS    */
/***********************************************************************
*****************************/
for(countp=1;countp<=nop;++countp)
{
for(county=1;county<=ys;++county)
{
for(countx=1;countx<=xs;countx++)
{
switch(cat)
{
case 'I':
if(strcmp(nam[countp],"SPM")==0)
{
if(tconc[countp][county][countx]>500)
strcpy(std[countp][county][countx],"unsafe");
else
strcpy(std[countp][county][countx],"safe");
}
else
{
if(strcmp(nam[countp],"SO2")==0)
{
if(tconc[countp][county][countx]>120)
```

```
strcpy(std[countp][county][countx],"unsafe");
else
strcpy(std[countp][county][countx],"safe");
}
else
{
if(strcmp(nam[countp],"NOx")==0)
{
if(tconc[countp][county][countx]>120)
strcpy(std[countp][county][countx],"unsafe");
else
strcpy(std[countp][county][countx],"safe");
}
else
{
if(strcmp(nam[countp],"CO")==0)
{
if(tconc[countp][county][countx]>5000)
strcpy(std[countp][county][countx],"unsafe");
else
strcpy(std[countp][county][countx],"safe");
}
else
strcpy(std[countp][county][countx],"NA");
}
}
}
        break;
case 'R':
if(strcmp(nam[countp],"SPM")==0)
{
if(tconc[countp][county][countx]>200)
strcpy(std[countp][county][countx],"unsafe");
else
strcpy(std[countp][county][countx],"safe");
}
else
{
if(strcmp(nam[countp],"SO2")==0)
{
if(tconc[countp][county][countx]>80)
strcpy(std[countp][county][countx],"unsafe");
else
strcpy(std[countp][county][countx],"safe");
}
else
```

```
{
if(strcmp(nam[countp],"NOx")==0)
{
if(tconc[countp][county][countx]>80)
strcpy(std[countp][county][countx],"unsafe");
else
strcpy(std[countp][county][countx],"safe");
}
else
{
if(strcmp(nam[countp],"CO")==0)
{
if(tconc[countp][county][countx]>2000)
strcpy(std[countp][county][countx],"unsafe");
else
strcpy(std[countp][county][countx],"safe");
}
else
strcpy(std[countp][county][countx],"NA");
}
}
}
	break;
case 'S':
if(strcmp(nam[countp],"SPM")==0)
{
if(tconc[countp][county][countx]>100)
strcpy(std[countp][county][countx],"unsafe");
else
strcpy(std[countp][county][countx],"safe");
}
else
{
if(strcmp(nam[countp],"SO2")==0)
{
if(tconc[countp][county][countx]>30)
strcpy(std[countp][county][countx],"unsafe");
else
strcpy(std[countp][county][countx],"safe");
}
else
{
if(strcmp(nam[countp],"NOx")==0)
{
if(tconc[countp][county][countx]>30)
strcpy(std[countp][county][countx],"unsafe");
```

```
else
strcpy(std[countp][county][countx],"safe");
}
else
{
if(strcmp(nam[countp],"CO")==0)
{
if(tconc[countp][county][countx]>1000)
strcpy(std[countp][county][countx],"unsafe");
else
strcpy(std[countp][county][countx],"safe");
}
else
strcpy(std[countp][county][countx],"NA");
}
}
}
      break;
default:
printf("\nfault in category of area ");
}
}
}
}   getch();
return 0;
}

/* FUNCTION STSRTS FOR STABILITY CLASS IN DAY TIME */
/*****************************************************************/
char sclassd()
{
char sclass1;
printf("\nEnter the surface wind speed at 10 mts from ground level not less than 2
mt/s\n");
scanf("%f",&sws);
printf("\nEnter the incoming solar radiation during day time as t:for strong,m:for
maderte,or l:for slight");
fflush(stdin);
scanf("%c",&sr);
if(sws==2.0)
{
if(sr=='t')
sclass1='a';
else
{
if((sr=='m')||(sr=='l'))
```

```
sclass1='b';
}
}
else
{
if(((sws>2.0)&&(sws<=3.0))&&((sr=='t')||(sr=='m')))
sclass1='b';
else if(((sws>2.0)&&(sws<=3.0))&&(sr=='l'))
sclass1='c';

else if(((sws>3.0)&&(sws<=5.0))&&((sr=='t')||(sr=='m')))
sclass1='c';
else if(((sws>3.0)&&(sws<=5.0))&&(sr=='l'))
sclass1='b';

else if(((sws>5.0)&&(sws<=6.0))&&((sr=='t')||(sr=='m')))
sclass1='d';
else if(((sws>5.0)&&(sws<=6.0))&&(sr=='l'))
sclass1='c';

else if((sws>6.0)&&((sr=='m')||(sr=='l')))
sclass1='d';
else if((sws>6.0)&&(sr=='t'))
sclass1='c';
}
printf("\nthe sclass is =%c",sclass1);
return(sclass1);
}
/*  STABILITY CLASS CALCULATION STARTS FOR NIGHT TIME    */
/**************************************************************/
char sclassn()
{
char sclass;
printf("\nEnter the urface wind speed at 10 mts from the ground level not less than 2mt/s
");
scanf("%f",&sws);
printf("\nEnter the niht cloud condition as 1:for 4/8 low cloud or 2:for 3/8 cloud ");
scanf("%d",&nc);
if((sws>2)&&(sws<=3))
{
if(nc==1)
sclass='e';
else
sclass='f';
}
else if((sws>3)&&(sws<=5))
```

```
{
if(nc==1)
sclass='d';
else
sclass='e';
}
else if((sws>5)&&(sws<=6))
sclass='d';
else
sclass='e';
printf("\nThe stability class=%c",sclass);
return(sclass);
}
```

CHAPTER: 8

RESULTS

Result of the model for prediction of air pollutant dispersion

Name of the industry:- Rourkela steel plant

Location of the industry:- Rourkela

Number of pollutants from the industry:- 2

Name of the season:- summer

Number of stacks in the area:- 9

Number of points in x direction:- 10

Number of points in y direction:- 10

Maximum wind prevails in the direction:- NW

The ambient air quality standards

Sl no.	category	SPM	SO2	NOX
1	Industrial and mixed use.	500	120	120
2	Residential and rural	200	80	80
3	Sensitive(hills etc.)	100	30	30

CONCENTRATION OF POLLUTANT SPM

CO-ORD IN X mts	CO-ORD IN Y Mts	CONC. IN microgram/cub.mts	STATUS
1000	0	7.943	SAFE
2000	0	15.345	SAFE
3000	0	35.275	SAFE
4000	0	42.643	SAFE
5000	0	55.432	SAFE
6000	0	38.784	SAFE
7000	0	22.543	SAFE
8000	0	18.521	SAFE
9000	0	10.890	SAFE
10,000	0	5.567	SAFE
1000	1000	7.762	SAFE
2000	1000	17.087	SAFE
3000	1000	35.321	SAFE
4000	1000	42.783	SAFE
5000	1000	53.590	SAFE
6000	1000	34.223	SAFE
7000	1000	20.789	SAFE
8000	1000	15.341	SAFE
9000	1000	9.065	SAFE
10,000	1000	5.519	SAFE
1000	2000	9.567	SAFE
2000	2000	13.782	SAFE
3000	2000	14.778	SAFE
4000	2000	20.960	SAFE
5000	2000	35.345	SAFE
6000	2000	28.112	SAFE
7000	2000	20.340	SAFE
8000	2000	19.151	SAFE
9000	2000	7.893	SAFE
10,000	2000	4.349	SAFE
1000	3000	11.987	SAFE
2000	3000	14.905	SAFE
3000	3000	16.654	SAFE
4000	3000	20.976	SAFE
5000	3000	19.007	SAFE
6000	3000	16.076	SAFE
7000	3000	10.876	SAFE
8000	3000	6.224	SAFE
9000	3000	5.915	SAFE
10,000	3000	3.668	SAFE
1000	4000	19.891	SAFE

2000	**4000**	**20.864**	**SAFE**
3000	**4000**	**21.998**	**SAFE**
4000	**4000**	**23.876**	**SAFE**
5000	**4000**	**20.228**	**SAFE**
6000	**4000**	**17.760**	**SAFE**
7000	**4000**	**13.765**	**SAFE**
8000	**4000**	**6.220**	**SAFE**
9000	**4000**	**3.918**	**SAFE**
10,000	**4000**	**1.456**	**SAFE**
1000	**5000**	**15.761**	**SAFE**
2000	**5000**	**18.003**	**SAFE**
3000	**5000**	**18.876**	**SAFE**
4000	**5000**	**16.245**	**SAFE**
5000	**5000**	**14.221**	**SAFE**
6000	**5000**	**9.207**	**SAFE**
7000	**5000**	**6.689**	**SAFE**
8000	**5000**	**3.943**	**SAFE**
9000	**5000**	**1.654**	**SAFE**
10,000	**5000**	**1.567**	**SAFE**
1000	**6000**	**13.678**	**SAFE**
2000	**6000**	**15.974**	**SAFE**
3000	**6000**	**17.532**	**SAFE**
4000	**6000**	**24.760**	**SAFE**
5000	**6000**	**32.289**	**SAFE**
6000	**6000**	**57.893**	**SAFE**
7000	**6000**	**25.112**	**SAFE**
8000	**6000**	**3.765**	**SAFE**
9000	**6000**	**2.911**	**SAFE**
10,000	**6000**	**1.562**	**SAFE**
1000	**7000**	**10.765**	**SAFE**
2000	**7000**	**8.561**	**SAFE**
3000	**7000**	**9.083**	**SAFE**
4000	**7000**	**7.441**	**SAFE**
5000	**7000**	**3.985**	**SAFE**
6000	**7000**	**1.224**	**SAFE**
7000	**7000**	**1.207**	**SAFE**
8000	**7000**	**0.819**	**SAFE**
9000	**7000**	**0.659**	**SAFE**
10,000	**7000**	**0.571**	**SAFE**
1000	**8000**	**5.456**	**SAFE**
2000	**8000**	**6.005**	**SAFE**
3000	**8000**	**7.216**	**SAFE**
4000	**8000**	**7.654**	**SAFE**
5000	**8000**	**4.965**	**SAFE**
6000	**8000**	**3.234**	**SAFE**

7000	**8000**	**0.675**	**SAFE**
8000	**8000**	**0.498**	**SAFE**
9000	**8000**	**0.765**	**SAFE**
10,000	**8000**	**0.225**	**SAFE**
1000	**9000**	**0.950**	**SAFE**
2000	**9000**	**0.760**	**SAFE**
3000	**9000**	**0.761**	**SAFE**
4000	**9000**	**0.784**	**SAFE**
5000	**9000**	**0.054**	**SAFE**
6000	**9000**	**0.651**	**SAFE**
7000	**9000**	**0.441**	**SAFE**
8000	**9000**	**0.175**	**SAFE**
9000	**9000**	**0.154**	**SAFE**
10,000	**9000**	**0.221**	**SAFE**
1000	**10,000**	**0.981**	**SAFE**
2000	**10,000**	**0.654**	**SAFE**
3000	**10,000**	**0.342**	**SAFE**
4000	**10,000**	**0.974**	**SAFE**
5000	**10,000**	**0.227**	**SAFE**
6000	**10,000**	**0.338**	**SAFE**
7000	**10,000**	**0.275**	**SAFE**
8000	**10,000**	**0.176**	**SAFE**
9000	**10,000**	**0.169**	**SAFE**
10,000	**10,000**	**0.131**	**SAFE**

CONCENTRATION OF POLLUTANT NOX.

CO-ORD IN X mts	CO-ORD IN Y mts	CONCENTRATION Microgram/cub.mts	STATUS
1000	0	29.455	SAFE
2000	0	44.712	SAFE
3000	0	63.785	SAFE
4000	0	76.987	SAFE
5000	0	94.342	SAFE
6000	0	69.234	SAFE
7000	0	61.456	SAFE
8000	0	54.993	SAFE
9000	0	38.915	SAFE
10,000	0	22.348	SAFE
1000	1000	27.765	SAFE
2000	1000	48.487	SAFE
3000	1000	64.785	SAFE
4000	1000	77.210	SAFE
5000	1000	91.542	SAFE
6000	1000	67.754	SAFE
7000	1000	59.543	SAFE
8000	1000	48.234	SAFE
9000	1000	36.412	SAFE
10,000	1000	20.952	SAFE
1000	2000	31.487	SAFE
2000	2000	46.126	SAFE
3000	2000	54.432	SAFE
4000	2000	65.437	SAFE
5000	2000	76.832	SAFE
6000	2000	69.410	SAFE
7000	2000	60.112	SAFE
8000	2000	52.167	SAFE
9000	2000	38.065	SAFE
10,000	2000	25.255	SAFE
1000	3000	33.330	SAFE
2000	3000	44.231	SAFE
3000	3000	52.945	SAFE
4000	3000	68.348	SAFE
5000	3000	65.421	SAFE
6000	3000	60.763	SAFE
7000	3000	51.876	SAFE
8000	3000	46.674	SAFE
9000	3000	29.549	SAFE
10,000	3000	25.931	SAFE

1000	**4000**	**38.289**	**SAFE**
2000	**4000**	**43.674**	**SAFE**
3000	**4000**	**69.651**	**SAFE**
4000	**4000**	**85.042**	**SAFE**
5000	**4000**	**81.664**	**SAFE**
6000	**4000**	**78.439**	**SAFE**
7000	**4000**	**66.752**	**SAFE**
8000	**4000**	**49.566**	**SAFE**
9000	**4000**	**37.862**	**SAFE**
10,000	**4000**	**26.221**	**SAFE**
1000	**5000**	**35.022**	**SAFE**
2000	**5000**	**54.759**	**SAFE**
3000	**5000**	**57.543**	**SAFE**
4000	**5000**	**87.498**	**SAFE**
5000	**5000**	**77.067**	**SAFE**
6000	**5000**	**56.589**	**SAFE**
7000	**5000**	**43.674**	**SAFE**
8000	**5000**	**34.789**	**SAFE**
9000	**5000**	**27.765**	**SAFE**
10,000	**5000**	**19.893**	**SAFE**
1000	**6000**	**32.546**	**SAFE**
2000	**6000**	**48.126**	**SAFE**
3000	**6000**	**50.432**	**SAFE**
4000	**6000**	**79.437**	**SAFE**
5000	**6000**	**72.832**	**SAFE**
6000	**6000**	**51.410**	**SAFE**
7000	**6000**	**40.112**	**SAFE**
8000	**6000**	**29.167**	**SAFE**
9000	**6000**	**21.065**	**SAFE**
10,000	**6000**	**16.255**	**SAFE**
1000	**7000**	**30.678**	**SAFE**
2000	**7000**	**39.543**	**SAFE**
3000	**7000**	**41.678**	**SAFE**
4000	**7000**	**68.112**	**SAFE**
5000	**7000**	**64.456**	**SAFE**
6000	**7000**	**33.349**	**SAFE**
7000	**7000**	**31.965**	**SAFE**
8000	**7000**	**24.564**	**SAFE**
9000	**7000**	**22.227**	**SAFE**
10,000	**7000**	**16.765**	**SAFE**
1000	**8000**	**21.745.**	**SAFE**
2000	**8000**	**34.765**	**SAFE**
3000	**8000**	**36.431**	**SAFE**
4000	**8000**	**63.590**	**SAFE**
5000	**8000**	**59.329**	**SAFE**

6000	**8000**	**30.487**	**SAFE**
7000	**8000**	**28.654**	**SAFE**
8000	**8000**	**20.589**	**SAFE**
9000	**8000**	**18.453**	**SAFE**
10,000	**8000**	**13.765**	**SAFE**
1000	**9000**	**15.364**	**SAFE**
2000	**9000**	**32.143**	**SAFE**
3000	**9000**	**37.685**	**SAFE**
4000	**9000**	**46.543**	**SAFE**
5000	**9000**	**43.767**	**SAFE**
6000	**9000**	**26.397**	**SAFE**
7000	**9000**	**20.723**	**SAFE**
8000	**9000**	**19.106**	**SAFE**
9000	**9000**	**17.864**	**SAFE**
10,000	**9000**	**12.789**	**SAFE**
1000	**10,000**	**14.623**	**SAFE**
2000	**10,000**	**30.854**	**SAFE**
3000	**10,000**	**35.991**	**SAFE**
4000	**10,000**	**44.784**	**SAFE**
5000	**10,000**	**40.000**	**SAFE**
6000	**10,000**	**21.998**	**SAFE**
7000	**10,000**	**19.827**	**SAFE**
8000	**10,000**	**18.139**	**SAFE**
9000	**10,000**	**15.176**	**SAFE**
10,000	**10,000**	**10.365**	**SAFE**

The maximum NOX concentration occurs at the point 5000.00000 0.00000.

The concentration at this point being : 94. 342

CONCENTRATION OF POLLUTANT SO2

CO-ORD IN X mts	CO-ORD IN Y Mts	CONCENTRATION Microgram/cub. mts	STATUS
1000	0	27.765	SAFE
2000	0	42.732	SAFE
3000	0	61.765	SAFE
4000	0	75.987	SAFE
5000	0	91.342	SAFE
6000	0	72.234	SAFE
7000	0	60.456	SAFE
8000	0	52.993	SAFE
9000	0	43.895	SAFE
10,000	0	22.348	SAFE
1000	1000	27.645	SAFE
2000	1000	47.487	SAFE
3000	1000	59.785	SAFE
4000	1000	73.290	SAFE
5000	1000	94.542	SAFE
6000	1000	71.754	SAFE
7000	1000	60.113	SAFE
8000	1000	52.234	SAFE
9000	1000	41.412	SAFE
10,000	1000	21.952	SAFE
1000	2000	31.487	SAFE
2000	2000	46.126	SAFE
3000	2000	54.432	SAFE
4000	2000	65.437	SAFE
5000	2000	76.832	SAFE
6000	2000	73.410	SAFE
7000	2000	63.112	SAFE
8000	2000	54.167	SAFE
9000	2000	40.065	SAFE
10,000	2000	18.255	SAFE
1000	3000	33.330	SAFE
2000	3000	44.231	SAFE
3000	3000	52.945	SAFE
4000	3000	68.348	SAFE
5000	3000	65.421	SAFE

6000	**3000**	**60.763**	**SAFE**
7000	**3000**	**51.876**	**SAFE**
8000	**3000**	**46.674**	**SAFE**
9000	**3000**	**29.549**	**SAFE**
10,000	**3000**	**17.931**	**SAFE**
1000	**4000**	**38.289**	**SAFE**
2000	**4000**	**43.674**	**SAFE**
3000	**4000**	**69.651**	**SAFE**
4000	**4000**	**85.042**	**SAFE**
5000	**4000**	**81.664**	**SAFE**
6000	**4000**	**72.439**	**SAFE**
7000	**4000**	**64.752**	**SAFE**
8000	**4000**	**48.566**	**SAFE**
9000	**4000**	**36.862**	**SAFE**
10,000	**4000**	**24.221**	**SAFE**
1000	**5000**	**34.022**	**SAFE**
2000	**5000**	**54.759**	**SAFE**
3000	**5000**	**57.543**	**SAFE**
4000	**5000**	**81.452**	**SAFE**
5000	**5000**	**75.067**	**SAFE**
6000	**5000**	**53.589**	**SAFE**
7000	**5000**	**41.674**	**SAFE**
8000	**5000**	**32.789**	**SAFE**
9000	**5000**	**26.765**	**SAFE**
10,000	**5000**	**18.893**	**SAFE**
1000	**6000**	**32.546**	**SAFE**
2000	**6000**	**48.126**	**SAFE**
3000	**6000**	**50.432**	**SAFE**
4000	**6000**	**79.437**	**SAFE**
5000	**6000**	**72.832**	**SAFE**
6000	**6000**	**51.410**	**SAFE**
7000	**6000**	**40.112**	**SAFE**
8000	**6000**	**29.167**	**SAFE**
9000	**6000**	**21.065**	**SAFE**
10,000	**6000**	**16.255**	**SAFE**
1000	**7000**	**28.678**	**SAFE**
2000	**7000**	**38.543**	**SAFE**
3000	**7000**	**39.678**	**SAFE**
4000	**7000**	**67.112**	**SAFE**
5000	**7000**	**64.456**	**SAFE**
6000	**7000**	**31.349**	**SAFE**
7000	**7000**	**27.965**	**SAFE**
8000	**7000**	**24.564**	**SAFE**
9000	**7000**	**21.227**	**SAFE**
10,000	**7000**	**15.765**	**SAFE**

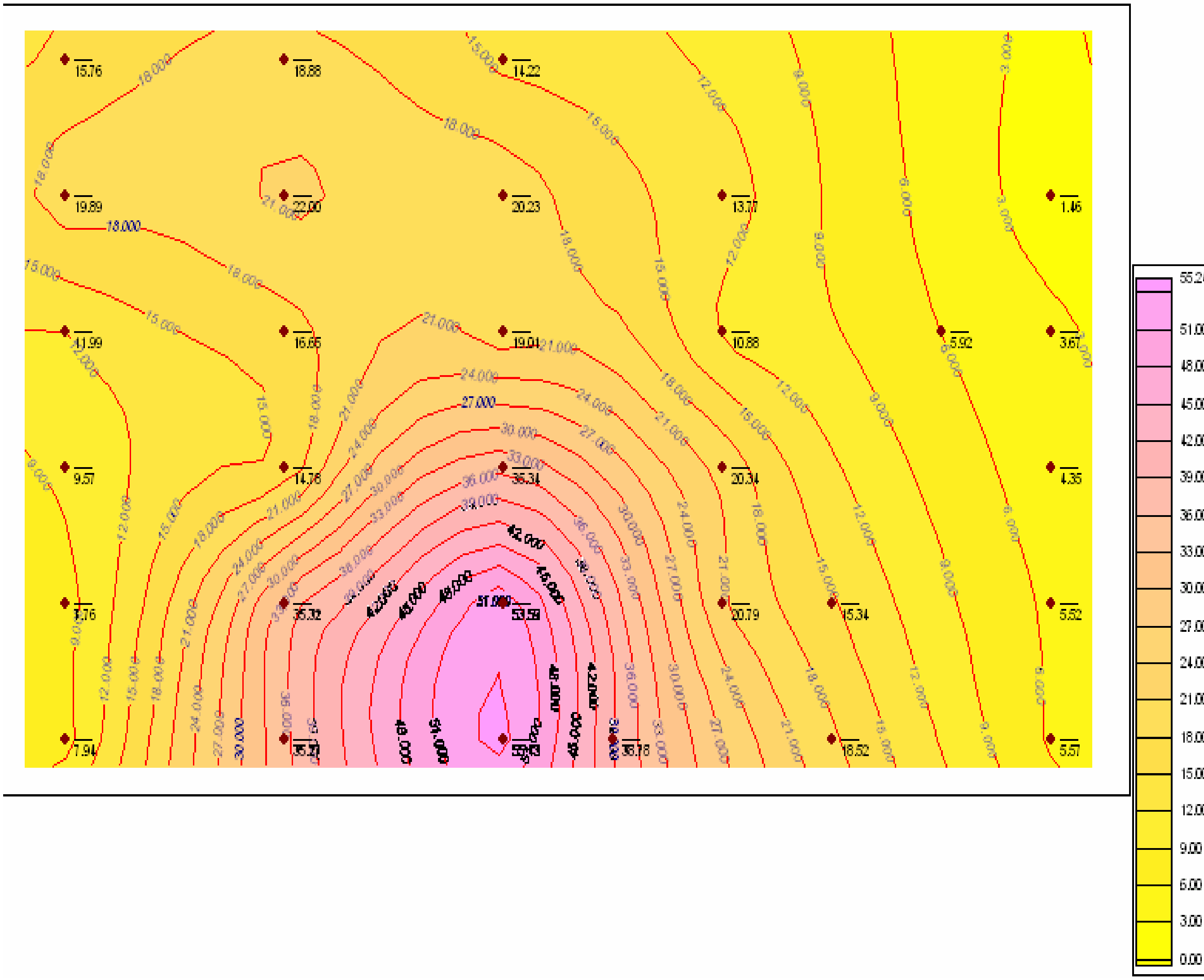
1000	**8000**	**21.745.**	**SAFE**
2000	**8000**	**34.765**	**SAFE**
3000	**8000**	**36.431**	**SAFE**
4000	**8000**	**63.590**	**SAFE**
5000	**8000**	**60.329**	**SAFE**
6000	**8000**	**29.487**	**SAFE**
7000	**8000**	**24.654**	**SAFE**
8000	**8000**	**20.589**	**SAFE**
9000	**8000**	**18.453**	**SAFE**
10,000	**8000**	**13.765**	**SAFE**
1000	**9000**	**15.364**	**SAFE**
2000	**9000**	**30.243**	**SAFE**
3000	**9000**	**32.785**	**SAFE**
4000	**9000**	**44.543**	**SAFE**
5000	**9000**	**41.767**	**SAFE**
6000	**9000**	**26.397**	**SAFE**
7000	**9000**	**18.123**	**SAFE**
8000	**9000**	**16.106**	**SAFE**
9000	**9000**	**14.814**	**SAFE**
10,000	**9000**	**10.569**	**SAFE**
1000	**10,000**	**11.623**	**SAFE**
2000	**10,000**	**28.854**	**SAFE**
3000	**10,000**	**31.991**	**SAFE**
4000	**10,000**	**42.784**	**SAFE**
5000	**10,000**	**39.000**	**SAFE**
6000	**10,000**	**21.998**	**SAFE**
7000	**10,000**	**18.327**	**SAFE**
8000	**10,000**	**13.139**	**SAFE**
9000	**10,000**	**11.876**	**SAFE**
10,000	**10,000**	**8.365**	**SAFE**

The maximum concentration occurs at the point 5000.0000 ,1000.000

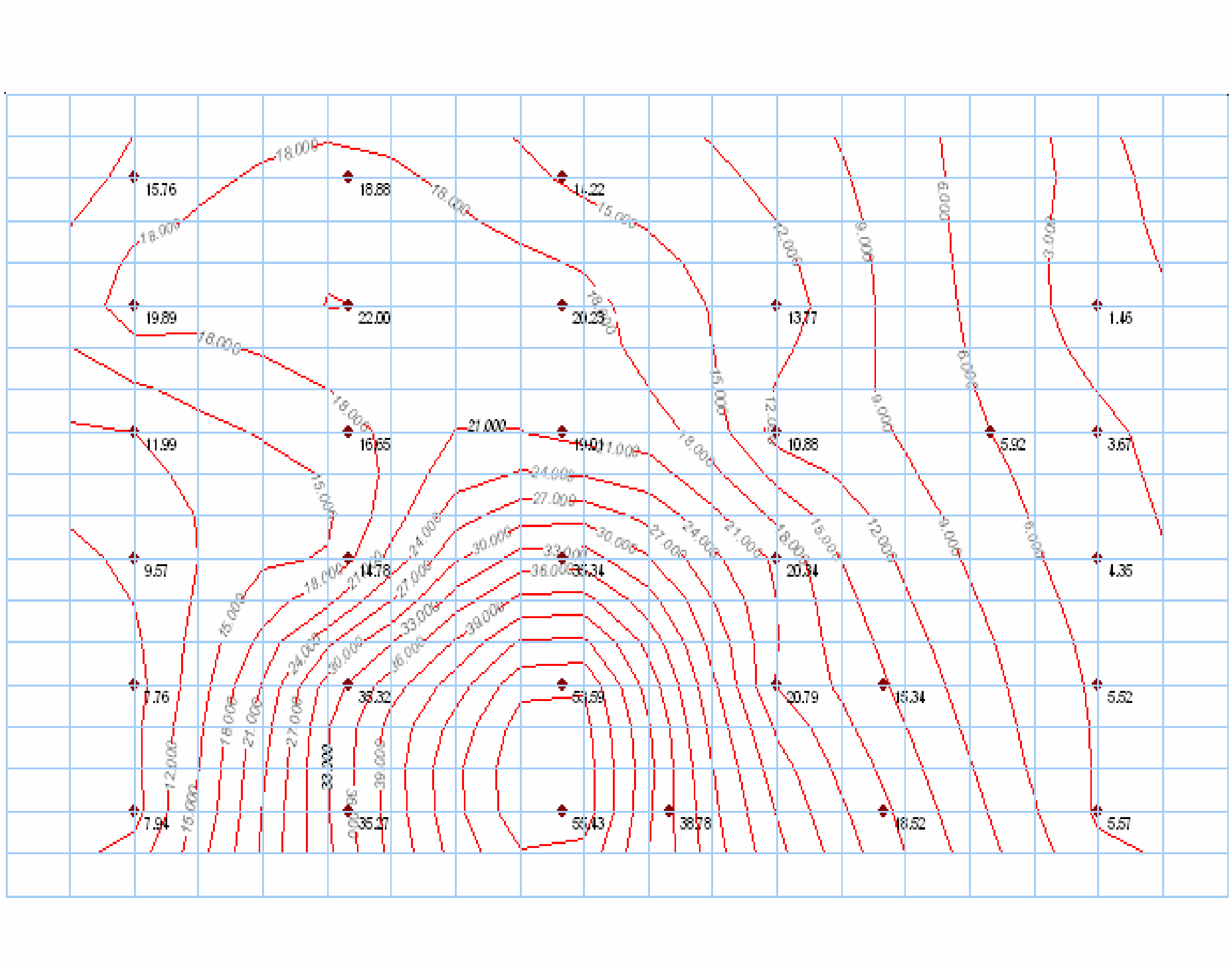
The concentration at this point being : 94.542

CHAPTER: 9

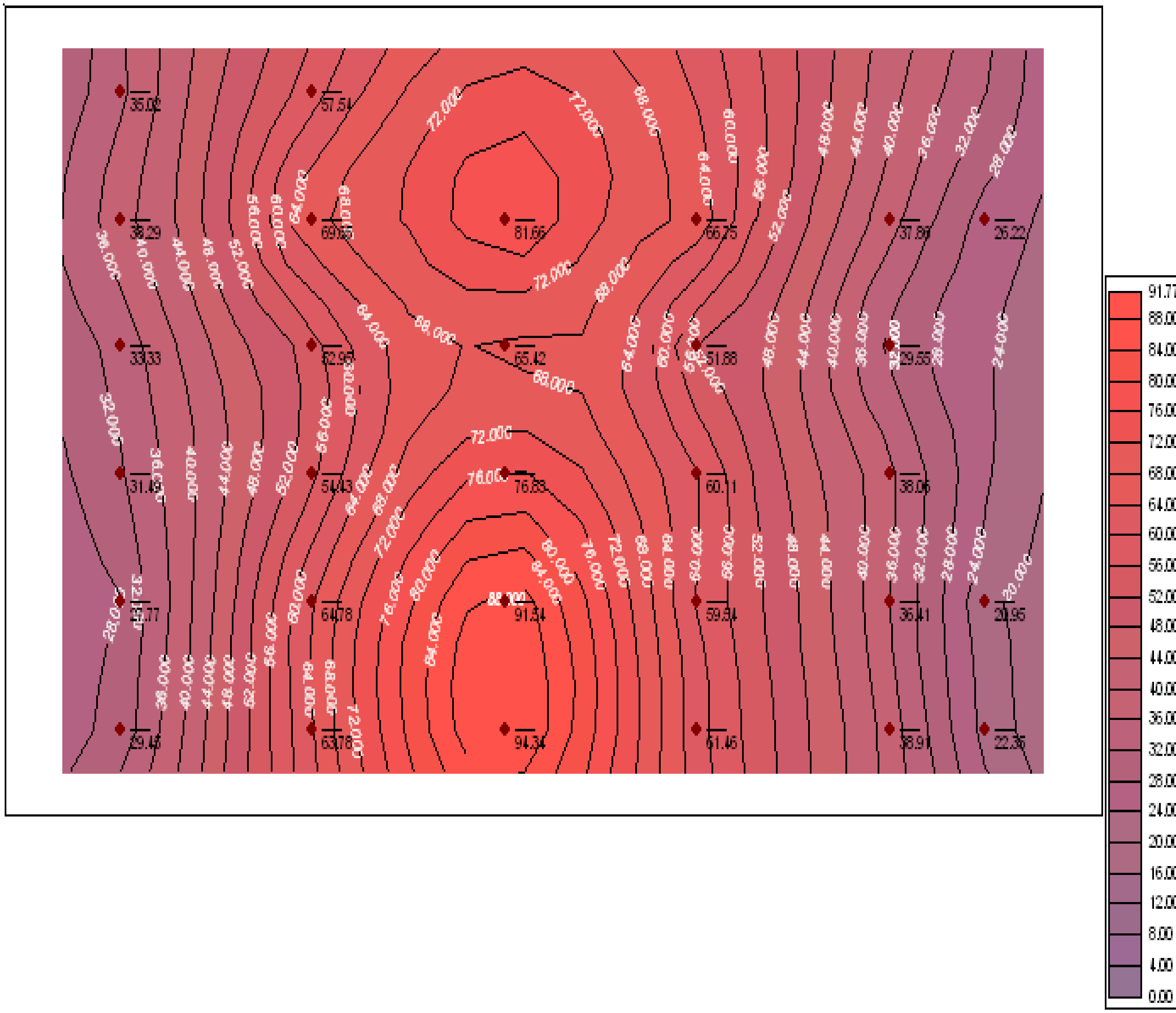
CONTOUR PLOTTING



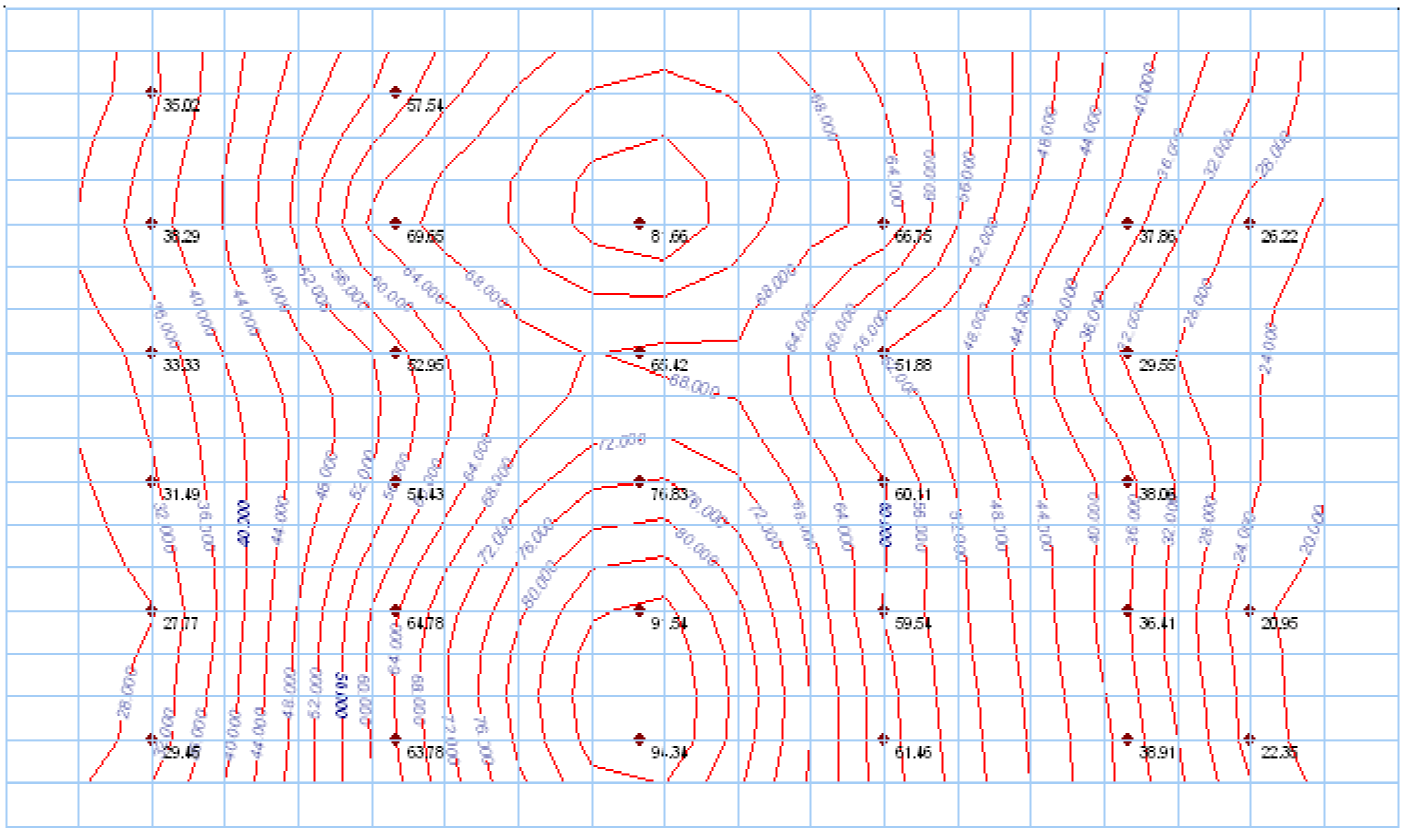
CONTOUR SHOWING CONCENTRATION OF SPM



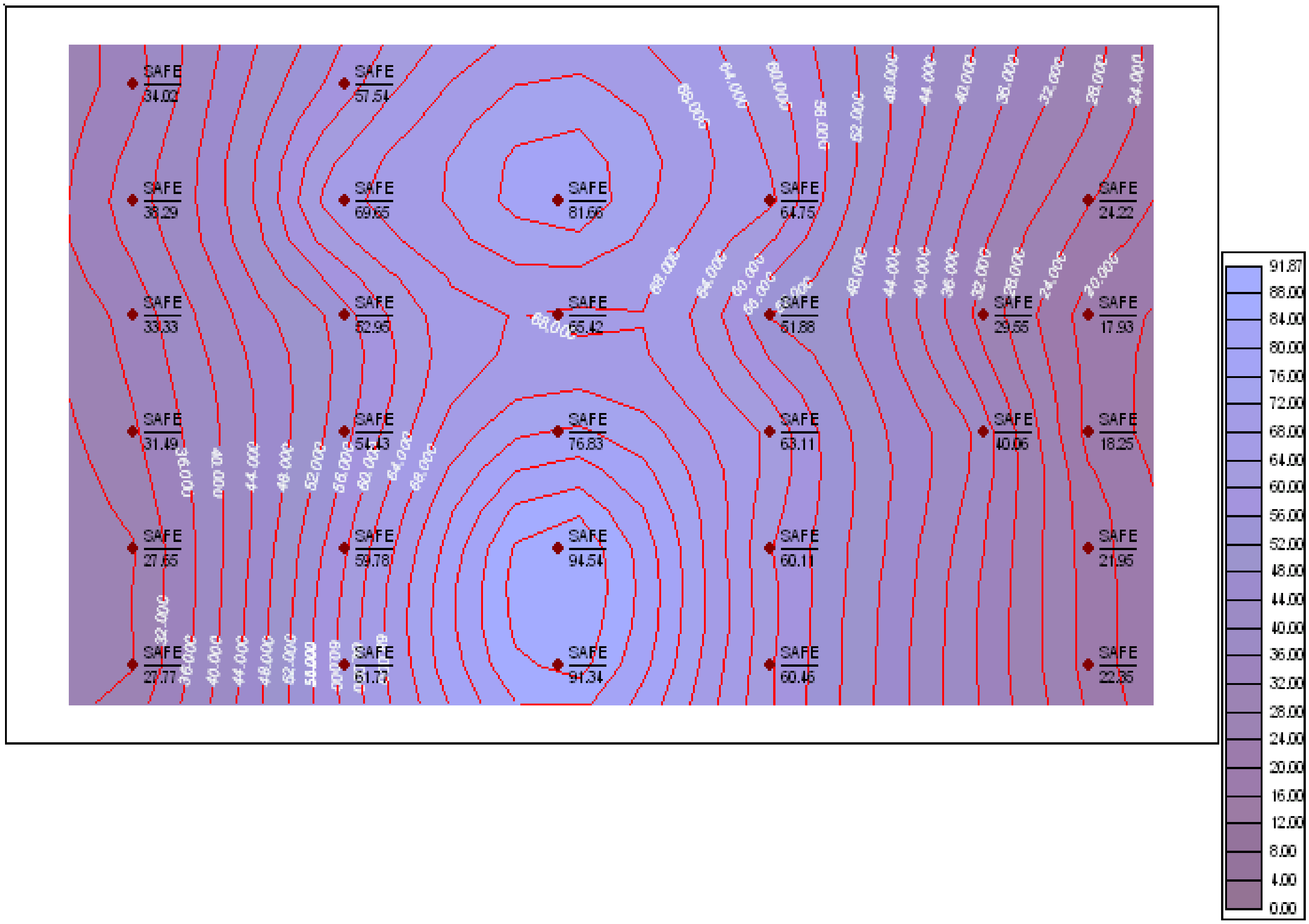
CONTOUR SHOWING CONCENTRATION OF SPM



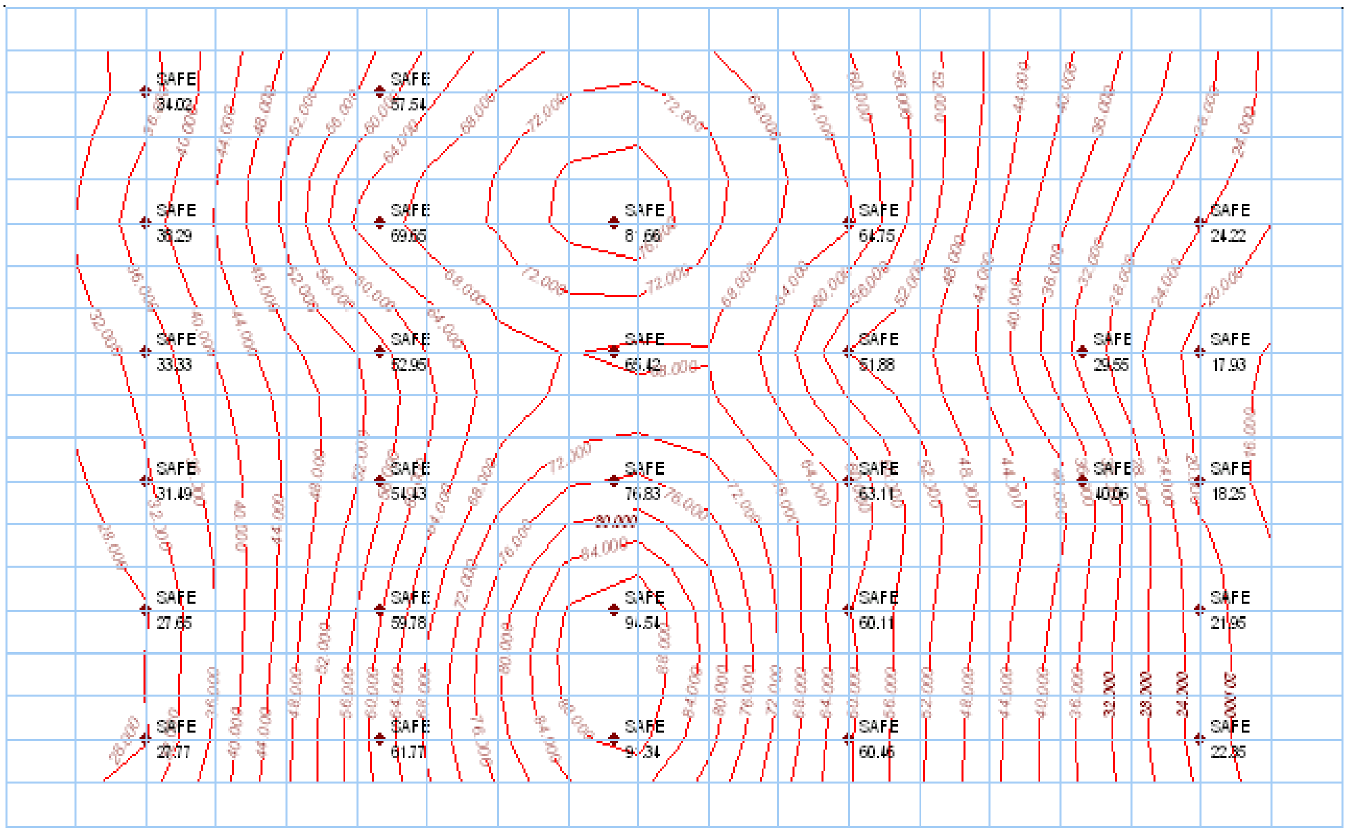
CONTOUR SHOWING CONCENTRATION OF NOX



CONTOUR SHOWING CONCENTRATION OF NOX



CONTOUR SHOWING CONCENTRATION OF SO2



CONTOUR SHOWING CONCENTRATION OF SO2

CHAPTER: 10

PRACTICAL STUDY REPORT

APPARATUS USED

1) **Respirable dust sampler**

MODEL

APM-260-----SPM

APM-211-----NOx,SO_2

2) **Aquadec**----To find concentration of So2 and Nox

Calculation of sample air volume and SPM and RPM concentration

Calculate the air volume sampled,

V= (Qi +Qf)/2)T

Where

V= STP-equivalent(25 deg. C. 1atm) air volume sampled, m3

Qi=Initial air flow rate,m^3/min.

Qf= final air flow rate,m^3/min.

T= sampling period in minutes.

SPM CALCULATION

SPM concentration,

SPM(µg/m3)= (Wf-Wi) X 106/V

where

Wf= weight of exposed filter, grams.

Wi = fare weight of filter, grams.

NO2 CALCULATION

REAGENT USED- Sodium Hydroxide

NOx(µg/m^3) = (µg NOx /ml) X 25/(V X 0.82)

SO2 CALCULATION

REAGENTS USED -0.04 M Potasium Tetrachloromercurate

SO2(ppmv) = SO2(µg/m^3) X 0.000382.

AMBIENT AIR QUALITY AROUND KUARMUNDA AREA

LOCATION	DISTANCE FROM SITE	RPM	SPM	SO_2	NO_X	DIRECTION
TAORU	1.5	128	273	15.32	11.28	SOUTH
SOHNA	2.5	137	434	29.57	9.99	S-W
KATIA	1.25	120	178	8.03	3.49	WEST
KHOTA KHANDWAL	0.75	178	230	6.18	18.86	S-E
BIRO	0.25	99	208	91.36	14.15	WEST
VEDVYAS	2.75	117	260	0.00	17.98	N-W
TUSARA	1.50	71	141	0.00	14.36	N-E
GOUDAPALI	3.50	74	149	13.03	10.88	S-E
BERUA	6	134	172	4.54	7.54	S-W
JASINGA	1.25	89	155	6.01	17.40	WEST
TAORU	1.5	143	226	0..00	14.54	SOUTH
SOHNA	2.5	110	277	0.00	13.23	S-W
KATIA	1.25	89	207	61.7	19.41	WEST
KHOTA KHANDWAL	0.75	126	265	83.31	24.63	S-E
BIRO	0.25	86	410	91.41	17.77	WEST
VEDVYAS	2.75	93	201	0.00	15.96	N-W
TUSARA	1.50	167	300	5.59	11.17	WEST
GOUDAPALI	3.50	112	271	11.23	13.90	SOUTH
BERUA	6	184	237	29.86	17.22	S-W
JASINGA	1.25	115	227	60.01	28.03	WEST

AMBIENT AIR QUALITY AROUND RSP

Class	SPM	SO_2	NOx
A	58.76(2,2)	45.77(2,2)	77.97(3,1)
B	90.47(3,3)	60.46(3,3)	271.81(3,1)
C	95.64(3,3)	54.79(4,4)	298.27(3,1)
D	87.86(6,6)	31.49(7,7)	227.03(4,2)
E	117.02(7,7)	48.02(7,7)	307.76(4,2)
F	99.57(8,9)	21.82(10.10)	186.64(6,4)

CONCLUSION

1 The program finds out ground level concentration near RSP.
2 It also compares concentration obtained at several points with national ambient quality standards. At all points concentration obtained were below the standard values and was thus within safe limits.
3 The percentage error found out was about 42%.

LIMITATIONS

1 The local pollution creating criteria were not taken into account .
2 During the diffusion of the pollutants, the effect of chemical and photo chemicals reactions was not considered.
3 The ground level was assumed to be level.

REFERENCES

1 Environmental impact analysis hand book--- Row and Wooten

2 Air pollution engineering----- Noel De Nevers

3 Environmental impact assessment and environmental management plan for modernization scheme of RSP-----M.N. Dastur and company

4 Environmental pollution control engineering------ C.S Rao

5 Journals by white young green environmental limited

6 WSDOT environmental procedures manual.

7 National environmental policy act,42 USC 4231.